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A VISIT TO THE YOSEMITE AND THE BIG TREES.

BY W. C. COKER.

Coming up the hot valley of the San Joaquin from Los Angeles I arrived, July 5th, 1908, at Merced, a small town on the Southern Pacific, where change is made to the short line of railroad that, after a short run, strikes the Merced river and follows up its canyon to El Portal, the gateway to the Yosemite. This stretch of road, climbing hard all the way, passes entirely through the chaparral covered foot hills and ends, at about three thousand feet altitude, on almost the exact lower edge of the magnificent coniferous belt that clothes the western flanks of the Sierras. Leaving the expansive plains of the San Joaquin valley, where there is little arborescent growth except along the rivers, the train passes through a region of low, rolling hills, covered at this season with dead and parched grass, and decorated with fine "specimen" trees of the blue or Douglas oak (*Quercus Douglasii*), that gives this region its peculiar park-like aspect not paralleled in any part of the east. This Douglas oak, with its bluish foliage, contrasting finely with its light gray bark, its wide spreading, rounded tops and isolated habit of growth, is one of the most beautiful and decorative of American trees.* In addition to the

*The well known live oaks (*Q. agrifolia*) of the Pacific slope, which may be seen at their best at Berkley, have much the same habit, but their crowns are even more expanded and their lower limbs often flatten out their branches on the ground.

blue oak there is scattered through the lower and more fertile valleys the California weeping or post oak (*Q. lobata*), a fine, tall tree, often with pendant branches.

After a short while we leave behind the lower, grassy foothills and enter the second or chaparral belt, of higher and more precipitous hills, where we follow the rugged canyon of the Merced. Here the whole surface is covered with the characteristic shrub or chaparral growth of low, harsh and intricate bush that is often impenetrable except for the trails. Of the plants that make up this inhospitable expanse the most abundant are chemisal or greasewood (*Adenostoma fasciculatum*), which often occupies many acres to the exclusion of all else; *Ceanthus cuneatus,* one of the most impenetrable of all; several species of *Manzanita* (*Arctostaphylos pungens, viscida, tomentosa*); the two buckthorns, *Rhamnus crocea* with pretty red berries, and coffee berry (*Rhamnus Californica*), with black berries; Christmas berry (*Heteromeles arbutifolia*), also with fine red berries; the dwarfed ash (*Fraxinus dipetala*); and the curious yerba santa or mountain balm (*Eriodictyon Californicum*), which has the leaves covered with an extremely sticky varnish. In July the yellow flowers of the California buckeye (*Aesculus Californica*) make this shrub a conspicuous part of the chaparral, particularly in the higher parts.

The only trees that rise above the general level of this chaparral are *Quercus Douglasii,* which is even more common than farther down, *Q. Wislizeni,* one of the western live oaks which does not enter the higher mountains, and the black oak or Kellogg's oak (*Q. Californica*), a common oak of higher altitudes which chooses the more protected situations. All of these oaks may be very much stunted in places and thus scarcely break the monotony of the brush.

The only pines that can meet the murderous conditions of the hills are the digger pine (*Pinus Sabiniana*) and the knob-cone pine (*Pinus attenuata*). The first is common on all the hills up to three thousand feet elevation, but it is a small pine and is

so scattered, and so sparse of foliage, that it has little effect on the general appearance of the country. Its cones are very large and heavy, and its seeds plump and edible. It is from the Digger Indians, who gather these seeds for food, that the tree takes its common name. The knob-cone pine is not nearly so common, and I did not see any of it from the train on my way up. It forms close, but very much scattered groves, and one often misses it in passing through the hills. This pine has the remarkable habit, in common with several other American pines, of retaining its cones unopened for many years. When fire kills the tree the cones open and all the seeds formed through the life of the tree are shed at once, thus planting a new grove at the time it is needed.[1] *Pinus attenuata*[2] is said to be more abundant north of the Merced than south of it.

The vegetation on the edges of the Merced river offers, of course, a striking contrast to that of the hills. Alders (*Alnus rhombifolia*) twenty or thirty feet high, large willows (*Salix fluviatilis* var. *argyraphylla*) very like our black willow, small willows (*Salix lasiandra*), ash (*Fraxinus biflora*), and good sized poplars (*Populus trichocarpa*) make up the larger growth. The most abundant shrubs are the button-ball (*Cephalanthus occidentalis*), the sweet-shrub (*Calycanthus occidentalis*),with fragrant brown flowers, *syringa* (*Philadelphus Lewesii*), most noticeable above El Portal, elder (*Sambucus glauca*), and the buckeye (*Aesculus Californica*), which grows also on the dry hills. Masses of the wild grape (*Vites Californica*) spread over the rocks and shrubs near the river.

Four or five miles below El Portal there appear along the river's edge a few small sentinels of yellow pine (*Pinus ponderosa*), sent down from the immense forest above, but giving little promise of what is to come. The California laurel (*Umbellularia Californica*) with strongly scented foliage also becomes notice-

[1] See John Muir's "Mountains of California," and my article on "Vitality of Pine Seeds and the Delayed Opening of Cones" in American Naturalist, 43: p. 677. Nov. 1909.

[2] *Pinus tuberculata* of some authors.

able about this time and extends on up to the Yosemite Valley. Of those great conifers that make so magnificent a display in higher altitudes the next to appear is the incense cedar (*Libocedrus decurrens*). It may be seen along the river just below El Portal.

Arriving at El Portal about dark, the night was spent there. An early start for Yosemite prevented much botanizing, but time was found to make out the more conspicuous growth of the place. The yellow pine (*Pinus ponderosa*) has here gotten out from the river bed and taken its place as one of the dominant trees of the hills. In fact, El Portal lies on the very edge of the coniferous-forest belt, and the red pine being the hardiest species of the belt is the only one represented here. The Digger pine still holds on at El Portal, but its upper limit is reached and it is lost almost immediately on starting for Yosemite.

Walking out from the hotel towards the east one passes small trees of blue oak (*Q. Douglasii*), golden cup oak (*Q. chrysolepis*), mostly low and scrubby, black oak (*Q. Californica*); and the shrubs, coffee berry (*Rhamnus Californica*), manzanita (*Arctostaphylos viscida*), with deep red, polished branches, California laurel (*Umbellularia Californica*), buckeye (*Aesculus Californica*)in flower in July, poison oak (*Rhus diversiloba*), dwarfed ash (*Fraxinus dipetala*), and a little *Rhamnus crocea,* a low shrub with red berries. A little way up the hill, behind the hotel, the peculiar sticky plant *Eriodictyon glutinosum* was found, and in a slight depression in the rocks two species of small willows were growing; one was *Salix lasiandra* and the other, *S. Bakeri,* a recently recognized species. Near these was found a small tree of the Oregon crab apple (*Malus rivularis*). The mountain mahogany (*Cercocarpus betulaefolius*) probably grows near here but was seen by me only once, on dry soil farther up the Merced.

Lower down the hill, in front of the hotel, the western redbud (*Cercis occidentalis*), an attractive small tree or shrub, and the elder (*Sambucus glauca*) were plentiful.

Along the river grew the plants that have already been described as occupying such a situation, and in wet places here was collected the large fern *Woodwardia spinulosa.* Among the

bare rocks or flats by the river were the peculiar little ferns *Pellea andromedaefolia* and *Pellea ornithopus,* the latter looking more like a toy fir tree than a fern. Forming mats on the large rocks on the lower hillside was *Selaginella rupestris,* a relative of the ferns, that is found in similar situations in the Eastern States.

Along the rapidly ascending road that climbs through the Merced gorge for twelve miles to the Yosemite Valley there is noticed a constant change in the vegetation with the gradually increasing altitude. Immediately above El Portal there appears sparingly along the river that peculiar evergreen tree, the California nutmeg (*Tumion Californicum*), with fruit about the size and color of a green gage plum. Inside the fruit[3] is a nutmeg-like seed that gives the common name to the plant. The tree, as it appears here, is small, scraggy and irregular in habit, and only a few reached twenty-five feet in height and eighteen inches in diameter near the base.

The California yew (*Taxus brevifolia*), an evergreen related to *Tumion,* is said to grow along this road, but I missed seeing it. Many of the plants mentioned at El Portal do not reach the Yosemite. The Digger pine ends where Tumion begins, then, a mile or so farther, and the red bud disappears, then in succession the buckeye, the ash, the grape, the poison ivy,[4] and *Tumion* (about half way up). *Calycanthus* and *Philadelphus* extend to within a mile or two of the valley floor.

A wax-myrtle (*Myrica Hertwegi*) is reported as growing along the Merced below the Yosemite, but I did not find it.

The blue oak does not ascend for any distance above El Portal, but the black oak and golden cup oak extend up through almost the entire coniferous belt, and are much larger and finer in the Yosemite than lower down.

In the dry wood along the road the strong scented tar-

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3 Strictly speaking, as the plant is a Gymnosperm, the whole "fruit" is a seed.

4 A few pieces of poison ivy have been found as high up as the valley walls, but it is extremely rare there.

weed, or bear clover, (*Chamaebatia foliolosa*), with minutely dissected leaves and white, strawberry-like flowers, is plentiful. It is called "bear clover," says Mrs. Brandegee, "because it bears not the least resemblance to clover, and the bear will have nothing to do with it."

The incense cedar (*Libocedrus decurrens*), already mentioned as beginning down by the river near El Portal, and the red pine (*Pinus ponderosa*) increase in size as they advance up the gorge until they reach the magnificent proportions exhibited in the Yosemite.

Entering the Yosemite Valley I drove through almost its entire length and stopped at Camp Currie, which is stationed under Glacier Point near the upper end. The camp was situated in a fine grove of red pine and incense cedar, and in the immediate vicinity are good specimens of silver fir (*Abies concolor*). A few trees of the Douglas spruce (*Pseudotsuga Douglasii*) grow on the talus at the foot of the south wall, a few hundred yards from the camp. There is none of the great sugar pine (*P. Lambertiana*) around this camp, and although it occurs sparingly farther down, it does not reach its best proportions at any place in the valley.

Other coniferous trees that occur in the valley and on the heights are, according to Mrs. Brandegee,[5] *Abies nobilis*, "in some places, as near the foot of the Yosemite fall," *A. magnifica*, "along the whole line of the south side of the valley and in great abundance near Glacier Point," *Tsuga Pattoniana*, "found on benches and mountain sides at Cathedral Peak," *Pinus monticola*, "Sentinel Dome, Cloud's Rest, etc."

The black oak (*Q. Californica*) and golden cup oak (*Q. chrysolepis*) become large trees here, thirty or forty feet high, and make a conspicuous part of the woods around the camp. Nuttall's flowering dogwood (*Cornus Nuttallii*) is another attractive small tree that is common here. Two good clumps of it stand just in front of the Le Conte Memorial Building, a stone lodge erected

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[5] The Flora of Yo Semite. Zoe, 2: 155. 1891.

in memory of Prof. Joseph Le Conte, the famous geologist and lover of these mountains, who died in the valley in July, 1901.

The shrubs of the dry and sandy valley floor around Camp Currie are *Ceanothus integerrimus,* a rather tall plant with feathery white flowers, *Ceanothus cordulatus,* a much lower and somewhat thorny spreading bush, coffee berry (*Rhamnus Californica*), manzanita (*Arctostaphylos viscida*), California rose (*Rosa Californica*), gooseberry (*Ribes Menziesii*), currant (*Ribes sanguineum*), wild cherry (*Prunus demissa*), and a little sage brush (*Artemizia tridentata*), the shrub that is so common in the dry deserts.

July is not the best time for flower display in the valley, as the long summer dry spell is then at its worst, but a number of attractive flowers still survive even in dry soil. Conspicuous among these is *Godetia quadrivulvera* with its variable flowers of purplish hues. The curious little low herb with pink and white clusters of flowers called pussy paws (*Spragua umbellata*) is common on the western side of Camp Currie and further down the valley.

Other attractive flowers are milkweed (*Asclepias speciosa*), yarrow (*Achillea millefolium*), the fragrant mint (*Monardella lanceolata*), the tall *Lopanthus urticifolius,* with purplish-pink flowers in spikes, *Penstemon heterophyllus,* the conspicuous lupine (*Lupinus parviflorus*), and our old eastern friend *Brunella vulgaris.*

Other less noticeable herbs of the dry flats are *Erigeron foliosus, Apocynum cannabinum, Lessingia leptoclada, Epilobium paniculatum, Eriogonum nudum, Lotus Nevadensis* and *Lotus crassifolius.* The Bracken fern (*Pteris aquilina*) is common. In slightly damper places grow *Geranium dissectum,* heartleaf (*Asarum Hartwegi*), wild strawberry (*Fragaria Californica*), columbine (*Aquilegia truncata*), and a small willow (*Salix lasiolepis*).

Along the trail which leads for about one mile up the valley to the Happy Isles grow nearly all the plants above mentioned, and where the soil is low and damp, as it is in several places near this trail, good sized trees of alder (*Alnus rhombifolia*), and poplar (*Populus trichocarpa*) appear. With these grow the

flowering raspberry or salmon berry (*Rubus parviflorus*), very like our eastern one, raspberry (*Rubus leucoderme*), the small dogwood with inconspicuous flowers (*Cornus occidentalis*) resembling our *C. Amomum,* and some of that most beautiful of all Yosemite shrubs, the western azalea (*Azalea occidentalis*).

Before reaching Happy Isles the trail passes, near the pumping station, through a wet marsh, where the alders and poplars grow into good sized trees. Both the large and small dogwoods appear on the edges of this marsh, and both raspberries also. Very conspicuous by the plank walk in the marsh were the cow parsnip (*Heracleum lanatum*), a rank growing, umbelliferous plant, a beautiful, tall lily with numerous small flowers (*Lilium parvum*), large lady ferns (*Asplenium felix-foemina*), two species of horsetail (*Equisetum robustum* and *Equisetum telmateia*), and the orchid *Habenaria leucostachys.* In a dry spot across the river, not far below the pumping station, was a colony of the mountain snow berry (*Symphoricarpus mollis*).

Between Camp Currie and the river are some damp, open meadows covered with fresh grass and flowers. Here were collected *Helenium Biglovii, Oenothera biennis* var. *grandiflora, Geranium incisum,* and *Brodiaea lactea.* Crossing the river here I found the june berry (*Amelanchier alnifolia*) as a low shrub on the river's edge, and in a sandy spot were a few trees of the lodge pole pine (*Pinus Murrayana*) that I have not seen mentioned as occurring on the floor of the valley.

Following the trail from this place to Mirror Lake I found growing on its banks *Salix lasiandra* and *Salix lasiolepis. Cornus occidentalis* grew in a damp place near, and in a wet open marsh a little way south of Mirror Lake, the following were collected: *Veronica sculettata, Stellaria longipes, Hypericum anegalloides, Helenium Biglovii, Dodecatheon Hendersoni, Mimulus Langsdorffii, Trifolium involucratum, Galium trifidum, Viola blanda, Ranunculus alismaefolius,* and, in a damp pasture near, *Lotus Torreyi.*

In the deep, rich wood, near the foot of Yosemite falls, were a good number of pine drops (*Plerospora Andromedea*), a large saprofhytic plant, one to three feet high, of a reddish brown color.

It is related to our indian pipe, and to the brilliant red snow plant (*Sarcodes sanguinea*) that occurs abundantly a little higher up.

The trail to Nevada Falls as it winds above Vernal Falls passes many attractive sun and rock loving species that are not found in the level valley. All are protected by some means against the excessive heat and drought to which they are exposed, as by dense hairs, succulent leaves, etc. A pretty little yellow composite covered with white wool (*Eriophyllum confertiflorum*) was in full bloom, as were also the succulent *Sedum obtusatum*, with yellow flowers, *Penstemon breviflorus*, with yellowish flowers striped with pink, and *Penstemon Newberryi*, with red flowers. *Gilia Hookeri*, with pretty pink and white flowers, formed low, dense mats, like our *Phlox subulata*. *Patentilla glandulosa*, with yellow, and *Scrophularia Californica*, with purplish flowers, grew singly in the crevices. Here also grew alum root (*Heuchera micrantha*) with tall white panicles of minute white flowers of a delicate, mist-like beauty.

The low spirea-like shrub (*Holodiscus discolor*), with leaves densely hairy beneath and white flowers in corymbs, and a low honeysuckle (*Lonicera interrupta*) were common.

The ferns that were able to survive the heat and dust of the rocky slopes were *Aspidium rigidum* var. *argutum*, *Pellea densa*, *Pellea Bridgesii*, *Pellea brachyptera*, *Cystopteris fragilis*, and *Cheilanthes gracillima*. The last has the leaves thickly clothed beneath with a dense felt of salmon colored hairs.

A species of mistletoe (*Phoradendron villosum*), not very different from our eastern one, was growing abundantly on *Quercus chrysolepis* along the trail.

Near the foot of Nevada Falls the trail passes a low place full of springs and several extensive pools of shallow water. In a damp spot here I found for the first time the silk-tassel tree (*Garrya Fremontii*), a rather tall shrub with opposite leaves and black juice. Other plants found here, and not seen before, were *Veronica serphyllifolia*, *Veronica Americana* and a species of *Podosciadium*.

Near the top of Nevada Falls grew *Cotyledon Nevadensis*, with yellow flowers and thick leaves, another species of alum root

(*Heuchera rubescens*), and the pretty red tipped paint brush (*Castilleia parviflora*).

On the rocks at the top of Nevada Falls I saw my first cedar (*Juniperus occidentalis*), a weather-worn old tree of great age. This tree is always low but sometimes gets a large trunk diameter, as much as ten feet according to Mrs. Brandegee (Flora of Yo Semite: Zoe, vol. 2, page 160).

The golden cup oak is also abundant here, as it is at all points at this elevation. It is hard at first to be convinced that the various forms of leaves that this plant exhibits, some with edges as smooth as our live oak, others as toothed and prickly as holly, can all belong to the same species. The acorns are equally variable.

Behind Camp Currie a steep and difficult trail leads up the almost perpendicular cliff for three thousand three hundred feet to Glacier Point above. The climb up this trail was a delightful experience. On the way are passed, in dry places, yellow pine (*Pinus ponderosa*), silver fir (*Abies concolor*), Douglas spruce (*Pseudotsuga Douglasii*), golden cup oak (*Quercus chrysolepis*), *Holodiscus discolor,* coffee berry (*Rhamnus Californica*), *Cotyledon Nevadensis* and most of the ferns that were seen on the rocks above Vernal Falls.

Along the course of a little brook up which the trail climbed for a good way near the top were growing *Azalea occidentalis,* in full bloom, the little bush maple (*Acer glabrum*), California laurel (*Umbellularia Californica*), small dogwood (*Cornus occidentalis*), flowering raspberry (*Rubus parviflorus*), and the flowers *Aquilegia truncata, Saxifraga peltata* and *Smilacina amplexicaulis.* Here also, to my surprise, were growing our own maiden hair ferns of the East (*Adiantum pedatum*).

At Glacier Point *Pinus Jeffreyi* occurs. It looks very like *P. ponderosa* and by some is considered only a variety of it. Under the pines here are extensive masses of the low bush chinquepin (*Castanopsis sempervirens*). Near the top of Sentinel Dome which rises up another thousand feet above Glacier Point I found a single tree of lodge pole pine (*Pinus Murrayana*), but did not find any *P. Monticola,* which is said to grow near the summit.

From Glacier Point the coach road winds over plateaus and ridges at an elevation varying from five to seven thousand feet, and passes the whole distance through as magnificent a forest as the earth can show. Yellow pine (*P. ponderosa*), Jeffrey's pine (*P. Jeffreyi*), white fir (*Abies concolor*), Douglas spruce (*Pseudotsuga Douglasii*), and incense cedar (*Libocedrus decurrens*) —all trees that we had already met with—here reach the largest proportions; but that grandest of all pines, the sugar pine (*P. Lambertiana*), seen before in the valley, but scarce there, is the most imposing spectacle of the forest. It often reaches a diameter of ten or twelve feet and a height of over two hundred feet. The small lodge pole pine is nowhere a conspicuous component of the forest, but a few well developed trees occurred along the road. They were shedding their pollen on July 7th.

On the floor of the forest through most of the distance were large expanses of the odd little bear clover or tar weed (*Chamaebatia foliosa*), already mentioned. The whole plant gives off a very penetrating aromatic odor (it can hardly be called a fragrance) that can be detected almost anywhere in the woods.

Open wet meadows were beautifully adorned with shooting stars (*Dodecatheon Jeffreyi*) and azaleas (*A. occidentalis*).

Arriving at Wawona late in the afternoon, I spent the night there and made an early start by the foot trail for the Mariposa Grove of Big Trees, about seven miles away.

Along this trail grew black oak, sugar pine, yellow pine, incense cedar, a great deal of *Chamaebatia, Ceanothus integerrimus, Ceanothus cordulatus* and the beautiful blue-flowered *Ceanothus parvifolius;* a little manzanita (*Arctostaphylos viscida*) and gooseberry (*Ribes Menziesii*), some currants (*Ribes sanguineum*), hazel nuts (*Corylus Californica*), roses (*Rosea Californica*), flowering raspberry (*Rubus parviflorus*), and in damp places *Cornus occidentalis.* Flowers in bloom were mariposa lilies (*Calicortas venustus* and its variety *purpurascens*), paint brush (*Castilleia parviflora*), iris (*Iris Hertwegi*), *Aquilegia truncata, Brunella vulgaris, Montia perfoliata, Lupinus polyphyllus,* and another large lupine that I have not yet been able to determine. In

a meadow near Wawona were *Godetia biloba, Mimulus Langsdorffii* and *Brodiaea grandiflora.*

About four hours were spent in the upper and lower groves of the Mariposa reservation of Big Trees (*Sequoia gigantea*). The two groves, containing together about five hundred of the sequoias, lie close together in a depression at an elevation of about five thousand five hundred feet.

Other coniferous trees associated with the sequoias are white spruce (*Abies concolor*), Douglas spruce, yellow pine, sugar pine and incense cedar. Very abundant on the ground was the low white-flowered snow bush (*Ceanothus cordulatus*) and the spreading blue or lilac-flowered *Ceanothus parvifolius,* one of the most beautiful shrubs I ever saw. *Chamaebatia* was common in dryer places, and roses (*R. Californica*), dogwood (*Cornus occidentalis*), azaleas (*A. occidentalis*), flowering raspberries (*Rubus parviflorus*), hazel nuts (*Corylus Californicus*), and braken fern were plentiful. *Lilium parvum, Cypripedium montanum,* iris, and the conspicuous and curious blood-red snow plant (*Sarcodes sanquinium*) added their bright colors to the forest floor.

The Mariposa grove of big trees is only one of a number of scattered groves of these giants that occur "along the west slope of the Sierra Nevada Mountains, from the middle fork of the American River to the head of Deer Creek, a distance of 260 miles."[6] In massiveness the largest trees of the Mariposa grove are equal to any, but as the tallest tree here is only 272 feet high there are a number of trees in other groves that surpass them in this respect, one for example in the Calaveras being 325 feet in height.

"The Grizzly Giant" is the most impressive and probably the oldest tree in the Mariposa grove. It is thirty feet in diameter at the base, and twenty feet at ten feet from the ground. Its top has been shortened and sadly battered by storm and lightning, and its base deeply burnt by many fires, but the impression that it gives of massive grandeur and venerable age has not been lessened

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[6]A Short Account of the Big Trees of California: Bulletin No. 28: U. S. Dept. of Agric. Division of Forestry.

by its many vicissitudes. The age of this patriarch has been variously estimated, but it is probable that it is not less than 4,000 or more than 5,000 years old.

From the exposed surface of a burn that had eaten deep into the body of one old tree I cut away the charred wood for a space at a distance of about a foot from the surface until I could count the annual rings. There were twenty-five of them to the inch. If this rate should be continued to the center of a tree twenty-five feet in diameter it would establish its age as 3,750 years, and it is not likely that many of the trees are older than this. However, we cannot accurately estimate their ages by such a method, as it is certain from the counting of rings in felled or burnt trees that the rate of growth varies greatly in different situations and at different ages. The greatest age that has been definitely established for any of the Big Trees is something over 4,000 years, a figure that was determined by John Muir by counting the rings in one of the largest trees in the King's River forest.

The impressiveness of the great sequoias surpassed even my exalted expectations. As with all great objects and scenes, the mind cannot conceive for a time the full report of the senses. Indeed, the imagination can never fully grasp the fact that this towering mass before us was in its prime in those forgotten days when the psalmist asked, "What is man, that thou art mindful of him? and the son of man, that thou visitest him?" Gradually the impression deepens until there falls upon us a sense of awe that cannot be produced by any of the temples or monuments that are built of hands.

"I am a part of all that I have met," says Ulysses, and, surrounded by the majesty of these cavernous groves, one can not but believe that had they stood guard over the history of man they would have added a finer fibre to his heart, and to his spirit a more noble aspiration.

CHAPEL HILL, N. C.

THE PRODUCTION OF MORBID CHANGES IN THE BLOOD VESSELS OF THE RABBIT BY ALCOHOL*

BY WILLIAM DE B. MAC NIDER, M.D.

Introduction.

The production of morbid changes in the lower animals by the use of drugs, various chemicals and, in some cases, by the employment of mechanical devices, has opened an instructive field for medical investigation. The general aim of such investigation has been, first, to determine whether definite and fairly constant pathologic changes could be produced by the use of various agents, and, second, after this has been determined, to arrest or to modify these changes by the use of other agents of a remedial nature.

In recent years there has been developed an extensive literature through the work of various investigators on experimental arteriosclerosis. The contributions of Josie, Kurt, Fischer, Klotz, Miller[1] and others have demonstrated that degenerative arterial changes follow the intravenous injection of adrenalin, digitalin and diphtheria toxin. Boinet and Romany and Klotz, using the *Bacillus typhosus* and streptococcus, have with the same animals produced arterial changes primarily affecting the intima, which is greatly thickened by endothelial proliferation.

Klotz,[2] in an interesting series of experiments, in which rabbits

* From the Laboratory of Experimental Therapeutics of the University of Chicago, S. A. Matthews, M.D., Director. A preliminary report; reprinted from The Archives of Internal Medicine, March, 1909.

[1] Miller (J. L.): Spontaneous Arterial Degeneration in Rabbits. Jour. Am. Med. Assn., 1907, xlix, 1789.

[2] Klotz: Centralbl. f. allg. Path. u. Physiol., 1908, xix, 535.

were suspended by their hind legs, demonstrated a rise in arterial pressure by the mechanical aid of an excessive amount of blood in the aorta and forelegs. Five animals thus treated developed changes in the aorta, carotid, subclavian and brachial arteries. No changes were demonstrated in the control animals. It has also been shown by Klotz[3] that bacterial toxins are capable of producing changes in the intima of the aorta and pulmonary artery.

Undoubtedly spontaneous arterial disease occurs in the lower animals, and perhaps more frequently in the rabbit, for this animal is peculiarly susceptible to surroundings and changes which depart from the normal. The occurrence of spontaneous aortic disease in rabbits has been demonstrated by Wells and also by Amy B. Miles.[4] The probability that such changes are not very frequently encountered is, however, strengthened by the report of Pearce,[5] who examined sixty-two rabbits. Of these, fifty were normal rabbits. Vascular lesions were found in but three, and in each case consisted of a few minute patches of sclerosis at the beginning of the aorta. In the remaining eleven animals degenerative changes were found in the aortas of four. These were animals that had been subjected to the action of typhoid and other sera.

The object of the present investigation was to determine whether sclerotic changes could be produced in the vascular system of a rabbit by the use of alcohol.

METHOD OF ADMINISTRATION, DOSAGE AND THE IMMEDIATE EFFECT OF ALCOHOL

At the commencement of this series of experiments the alcohol in 30 per cent. solution was given intravenously. By such a method of administration, changes, if any should develop in the

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3 Klotz: Brit. Med. Jour., 1906, ii, 1767.

4 Miles (Amy B.): Spontaneous Aortic Diseases in Rabbits. Jour. Am. Med. Assn., Oct. 5, 1907, xlix, 1173.

5 Pearce (R. M.): Occurrence of Spontaneous Arterial Degeneration in the Rabbit. Jour. Am. Med. Assn., 1908, li, 1056.

vessels, could be logically ascribed to the direct action of the alcohol, and thus there would be eliminated the many modifications to which the drug is subjected before it reaches the vessels when it is introduced into the stomach. The intravenous injections were, however, rapidly followed by the formation of thrombi in the neighboring vessels, necessitating the drug being given by the stomach. For this purpose a small, soft rubber catheter was used.

In each case for the first few days 25 c.c. of a 10 per cent. solution was given once a day. After this the quantity was increased to 50 c.c. and the strength of the solution to 20 per cent.

The immediate effect of the alcohol was greatly enhanced by this method of administration, the excitement being marked. In all the animals the respirations and heart were markedly accelerated. This condition usually lasted about an hour. Then the animal would become drowsy. At this stage voluntary movements were slow and all muscular acts imperfectly coordinated, Following an hour or more of drowsiness the animals would usually fall asleep for two to six hours. Their return to the normal was gradual, the effect of the alcohol lasting on an average of twelve hours.

GROSS AND MICROSCOPIC CHANGES PRODUCED IN THE VESSELS OF ANIMALS SUBJECTED TO THE ACTION OF ALCOHOL

In the following observations the aorta was the vessel selected for study in determining the presence or absence of sclerosis. The agents used were Zenker's fluid, hematoxylin and eosin:

Experiment 1.—The subject received 50 c.c. of 20 per cent. alcohol for thirty-four days. The aorta at its origin and for a distance of 1 cm. was visibly thickened. Just at its commencement and situated so as to encroach on one of the coronary openings there was a nodule the size of a pin-head. The microscopic examination of the tissue taken from the thickened portion of the arch showed very clearly, when compared with sections of the thoracic portion of the aorta, a thickening of both the inner and middle coats of the vessel. This change in the internal coat was due to a proliferation of the connective-tissue cells in the subendothelial layers. In the media small round cells and fibroblasts were numerous between the muscle bundles. The muscular element was not degenerative. There had been no transition of the connective-tissue

cells into true fibrous tissue. The change was an early one and apparently as extensive in one coat as in the other. The nodule referred to was situated in the intima and was formed principally of elongated cells, which stained poorly and had undergone a granular, non-fatty degeneration. There were no adjacent changes in the media.

Experiment 2.—The subject received 50 c.c. of 20 per cent. alcohol for forty days. The aorta showed no evidence of atheromatous changes. Sections through the vessel at various levels showed no evidence of disease.

Experiment 3.—The subject received 50 c.c. of 20 per cent. alcohol for forty days. The thoracic aorta was the seat of a clearly defined atheromatous ulcer. Elsewhere the vessel was normal. The ulcer in the thoracic involved both the intima and media. Its floor was formed by the adventitia, and consisted of young connective tissue in the cellular and fibrous stages. Calcification was not present.

Experiment 4.—The subject received 50 c.c. of 20 per cent. alcohol for thirty days. The aorta was normal in structure.

Experiment 5.—The subject received 50 c.c. of 20 per cent. alcohol for twenty days. The animal was accidentally killed. The aorta presented no evidence of disease.

Experiment 6.—The subject received 50 c.c. of 20 per cent. alcohol for forty-two days. The aortic valves were thickened, and felt rough. The aorta showed two calcareous patches, one in the arch and one in the thoracic portion. There was a diffuse thickening of the inner and middle coats, the histologic appearance bearing a close resemblance to the changes seen in the aorta of the first animal. The areas of calcification occupied chiefly the intima, but extended also to the media, having ruptured the inner elastic lamina. Here it may be interesting to note that the hyperplastic changes which have been demonstrated in the inner coats of the aorta were not preceded by localized degeneration and weakening of the middle coat. The changes in the vessel were usually of a diffuse character. There was evidently no pronounced localization in the action of the substance or substances which induced changes in the vascular system from the continuous use of alcohol.

Experiment 7.—The subject received 50 c.c. of 20 per cent. alcohol for fifty days. The aorta showed an atheromatous ulcer 1 cm. from the aortic ring and a small warty growth on one of the aortic valves. The ulcer involved the intima and a portion of the media. The amount of cell infiltration in the media was less than in preceding cases.

Experiment 8.—The subject received 50 c.c. of 20 per cent. alcohol for forty-four days. There were no changes in the intima. Sections through the aorta at various levels frequently showed in the middle coat, between the muscle bundles, collections of small round cells. Other than this there was no evidence of connective-tissue overgrowth.

Experiment 9.—The subject received 50 c.c. of 20 per cent. alcohol for thirty-three days. The upper portion of the aorta showed several areas that were visibly and palpably thicker than the surrounding vessel. Sections through these areas showed the thickening to be due to a proliferation of the subendothelial connective tissue. The cells and nuclei stained well. There was no evidence from the staining reaction or from the size of the cells or their nuclei that the degenerative changes existed.

Experiment 10.—The subject received 50 c.c. of 20 per cent. alcohol for twenty-four days. The aorta was normal.

Experiment 11.—The subject received 50 c.c. of 20 per cent. alcohol for fifty days. The aorta showed a patch of thickening behind one of the semilunar valves and in the thoracic aorta there were several deep ulcers. Opposite the larger of the ulcers the vessel was bulged (early aneurism formation). This area measured 1 cm. in its longest diameter. The floors of the smaller ulcers, which were not so deep as the larger one, were found in the middle coat. The floors did not consist of the histologic elements of the media, but of young connective tissue fibres and spindle-shaped cells. This reparative fibrosis lessened as sections away from the ulcer were examined. It did not come to a clear-cut termination, but the marked localized connective tissue overgrowth existed to a less degree in a general thickening of the middle coat at some distance from the ulcers.

Experiment 12.—The subject received 50 c.c. of 20 per cent. alcohol for fifty-four days. The aorta was the seat of several areas of nodular sclerosis, the nodules being to a great extent confined to the intima, while the media presented the usual diffuse connective-tissue hyperplasia.

Experiment 13.—The subject received 50 c.c. of 20 per cent. alcohol for fifty-four days. There was diffuse cell infiltration of the middle coat.

A STUDY OF THE AORTAS OF PRESUMABLY NORMAL ANIMALS

The animals used as controls were all full grown; eight of the number were old. The aortas of the sixteen control animals were examined in the same way as the vessels of those animals subjected to the action of alcohol.

The following is a summary of the changes found:

In thirteen of the animals the aorta was free from both general and localized thickening. In the three remaining animals the vascular changes were as follows: In one aorta there was a sclerotic nodule in the arch; in the two remaining vessels atheromatous ulcers were found in the thoracic aorta. There was an absence of diffuse thickening, especially in the media. This observation naturally suggests that the etiologic factor in the

development of the vascular changes in the control animals was of a localized nature. The frequency with which diffuse changes are seen in the vessels of the alcoholic animals suggests some diffusely acting agent.

PRELIMINARY DEDUCTIONS

The number of animals used in these experiments is too small to permit the formulation of any permanent conclusions from the results. Definite sclerotic changes developed in the aorta in a decided majority of the animals that were subjected to the action of alcohol. Such was the case in nine of the thirteen animals used. These changes varied in intensity from a small round-cell infiltration of the media to the production of an atheromatous ulcer 1 cm. in its longest diameter. The most constant change was a diffuse thickening of the media. Similar changes were present in the vessels of relatively few normal animals. The changes which were present were localized and were not nearly so extensive as those seen in the vessels of the alcohol animals, even though the control animals were old, the other animals not being full grown.

A continued study of this subject will consist in the following measures: First, an attempt will be made to demonstrate morbid changes in the vessels of a larger series of animals. Second, if it can be definitely proved that such changes are produced fairly constantly by the use of alcohol, an endeavor will be made to determine whether the alcohol *per se* is capable of causing such results, or whether the changes arise indirectly by the action of alcohol inhibiting the activity of the various digestive enzymes and predisposing to or directly leading to some type of autointoxication.

CHAPEL HILL, N. C.

ALCOHOL *

BY WM. DE B. MAC NIDER, M.D.

(a) The Pharmacological Action of Alcohol.

(b) Logical Indications for the Use of Alcohol as a Therapeutic Agent.

(c) Changes Produced Experimentally in the Blood Vessels of Rabbits Subjected to the Action of Alcohol.

The subject under discussion may be approached and studied with benefit from many points of view. At the present time a consideration of alcohol from a sociological viewpoint would be of interest, but for many reasons, this side of the subject will be severely left alone.

Like many other questions of medical interest, the older they are, the more they are subjected to discussion and criticism, the more interesting they become; especially in these latter years when they can be approached, studied, and in some cases solved by scientific methods of investigation. Such a statement is certainly true concerning this old yet often discarded drug — alcohol.

Occurring as it does, free in nature, or at least, the elements which enter into its formation are free, namely, ferments and starches, it was natural enough for the ancients to use the drug as a remedial agent and a beverage. Judging from the older writings, the influence of alcohol upon the nervous system and the circulatory system, both in a dilute and a concentrated form, was well understood. The modern conception of the action of alcohol upon the body both before and after absorption, and in dilute and concentrated solutions, differs in some essentials and in many

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details from the views regarding its action which were held some years ago. This change has been largely due to the study of the drug from an experimental laboratory side. Approached in such a way, many of the confusing factors can be eliminated which exist in a very pronounced and exaggerated form at the bedside, which may mask and overshadow the action of a drug and render deductions which are seemingly logical fallacious. We frequently hear the remark that conclusions arrived at when the individual is eliminated from the equation must be of slight practical value. In this statement there is a pronounced element of truth which can with ease be discerned when we think of the influence the mind exerts over the various functions of the body in health and in disease. This influence cannot be considered as it should be and cannot be appreciated in most laboratory work. The mental status of an individual usually plays but a feeble part in determining the action of a drug and on this account the pharmacological action of the vast majority of drugs can be scientifically determined and logical deductions for their use arrived at by laboratory experiments upon anesthetised animals.

THE PHARMACOLOGICAL ACTION OF ALCOHOL

The action of alcohol when used externally depends upon the concentration of the solution employed. The stronger solutions, 80-95 per cent., are not so strongly germicidal as the weaker, 30-40 per cent., solutions. When the stronger solutions come in contact with the bacterial cell they produce a superficial coagulation of the albuminous material of the cell body which prevents the penetration of the drug and lessens its germicidal power. In addition to this direct germicidal action, alcohol indirectly acts as a germicide by dissolving fatty material in and around the hair follicles and allowing a deeper and more perfect action of other germicides, such as the bichloride of mercury.

The influence of alcohol on digestion, and the role it plays as a food are two questions which have been severely battered by laboratory investigations and clinical observations.

When the drug is used in a concentrated form it undoubtedly

increases the amount of blood to the gastro-intestinal tube. This increased vascularity persists, and as a result of its persistence leads to an over-production of mucous and a connective-tissue hyperplasia in the mucous and sub-mucous coats of the stomach and intestines. The mucous which results from an increased blood supply to the mucous glands is readily decomposed by the intestinal bacteria with the formation of acids or fermentation. Just what part these acids play in chronic alcoholic auto-intoxication, and to what extent they inaugurate the diffuse connective-tissue overgrowth in the body, which is most marked in the liver, blood vessels, and kidneys, is an intensely live question, with which we hope to do something experimentally.

When alcohol is used in small amounts and in a well diluted form, before or during meals, it acts to a less degree as an irritant, but simply this action increases the amount of blood to the stomach and intestinal glands. As a result of the glands receiving more blood, their activity is increased and there is an increased output of digestive juices.

When alcohol is given undiluted, with the idea in view of aiding digestion, it undoubtedly does harm, as the stronger solutions check the action of unorganized ferments.

Alcohol is readily absorbed from the intestines and is usually quickly oxidized into its final endproducts, CO^2 and H^2O.

The influence which this drug has after its absorption is the part of the alcohol question which has been most severely discussed by the laboratory student and clinician. As a result of the rapid combustion of the drug after its absorption it furnishes heat and energy to the body, lessens the combustion of fats and carbohydrates, and in this way indirectly acts as a food. This point seems fairly well established and is generally accepted. The point concerning the action of alcohol which is still the subject of a lively discussion is whether or not it can be considered a circulatory stimulant. If alcohol be given to a healthy individual in a fairly strong solution it is the common observation that the heart quickens its action, there is an increased output of blood into the arterial system and the pulse tension is raised. A similar effect upon the circulatory system can be produced by

other gastric irritants, such as ammonia, ether, and capsicum. This stimulating action of the drug is very likely a gastric reflex. To determine this point we have on several occasions anesthetised a rabbit with chloral hydrate solution and connected the animal's carotid artery to a mercury manometer, so as to accurately record the arterial pressure. At intervals of fifteen minutes a small soft rubber catheter was introduced into the animal's stomach and 30 c.c. of a 30 per cent. solution of ethyl alcohol administered. The heart's rate and the animal's blood pressure were recorded every five minutes. There was no appreciable rise in blood pressure and but a very slight acceleration of the heart. These experiments certainly support the the belief that the accelation of the heart after the use of alcohol is a gastric reflex from irritation and that when the reflexes have been abolished as a result of the anesthesia the quickening of the heart and the subsequent rise in pressure from alcohol does not occur.

I am firmly of the belief that there are certain infectious diseases in which alcohol is of the greatest value as a circulatory support. I do not say stimulant, for with the ordinary interpretation of this term it would convey a false meaning. In pneumonia, typhoid fever and, more rarely, tuberculosis, we frequently see patients with a fast heart, a soft, small pulse, rapid respirations, and muttering or maniacal delirium. In short, these are outward manifestations of an over-stimulated central nervous system. The stimulus is the toxin, and it at first gives rise to this picture of stimulation, and unless it is stopped leads to overstimulation, fatigue, and a state of inactivity of the central nervous system which is manifested by a state of coma which frequently precedes death.

In such cases following the use of alcohol, especially in pneumonia, it is a common observation to note that the delirium lessens, sleep is induced, the heart's action becoming slower and stronger. The cells of the arterial nervous system are so depressed that they no longer respond to the stimulus of the toxin, the state of fatigue is prevented and the integrity of the cell is maintained. It has been clearly demonstrated, experimentally, by Dolly that as a result of over-stimulation structural changes

of a degenerative nature develop in the cells of the central nervous system, and furthermore that these changes frequently lead to an actual rupture and death of the cells.

EXPERIMENTAL ARTERIO-SCLEROSIS BY THE USE OF ALCOHOL

As a result of the use of the higher animals for teaching and experimental purposes, there has developed in this country an enormous amount of literature along the line of experimental pathology. Such work is not only essential to the proper teaching of several of the rudimentary branches in the medical curriculum, but it is the only way which many problems in pathology and pathological physiology can be approached and solved.

The blood vessels of the lower animals were early used as a field for such experimental work. Among the investigators who have attempted to produce atheromatous changes in the vessels are Josie, Fischer, Kurt, Klotz and Miller. Various drugs and other agents have been employed, but the most satisfactory results have been obtained by Miller, who used solutions of adrenalin and physostigmine.

It is a well known fact that the majority of individuals who use alcohol continuously, develop some type of arterio-sclerosis. The severity of the process varies from a slight induration of the aortic valves and a few atheromatous patches in the aortic arch to a diffuse arterial sclerosis which exists in the peripheral vessels as the classical "pipe stem" arteries.

It was the object of our investigations to determine, first, if such changes could be produced experimentally by alcohol in the vessels of the lower animals. Secondly, to determine, if possible, if these changes were due, *per se*, to the alcohol, or if other secondary factors entered into their production; and thirdly, to attempt to find some remedial agent which would have either a direct or indirect influence upon the morbid process.

The rabbit was the animal chosen for this work, as they are comparatively cheap and easy to handle. The alcohol was given by the stomach through a soft rubber catheter. For the first few days 25 c.c. of a 10 per cent. solution was given, and after this

the amount was increased to 50 c.c. and the strength of the solution to 20 per cent. A few of the animals died from accidental causes. In those that lived the alcohol was continued for nearly eight weeks. At the end of this time the rabbits were killed by chloroform, complete post-mortems were held, and the heart, aorta and iliac vessels were removed for microscopic study.

There were fourteen animals in this first series which were subjected to the action of alcohol as described above. Of the fourteen animals the vessels of ten showed distinct evidence of some type of arterial degeneration. These changes varied greatly as to the severity and location. In four of the animals the vascular changes were evidently early and consisted chiefly in a diffuse connective-tissue overgrowth in the cellular stage, which affected principally the middle coat of the vessels, but which was beginning to be more pronounced around the blood vessels of the middle coat, *e. g.*, the vasa vasorum. This localization of young connective tissue around these nutrient vessels of the middle coat is important. For when the connective tissue reaches its fibrillary stage and contracts it will inevitably compress the lumen of the vessel which it surrounds and prevent an adequate amount of nutrition in the form of blood from reaching the media. This will aid, if not directly cause, degenerative changes of the middle coat.

In the vessels of three of the animals the most marked changes were to be found in the inner coat. This consisted in a subendothelial hyperplasia, which existed in patches, and which was most marked in the aortic arch. A few of the patches were losing their nuclei, failing to stain and beginning to develop into atheromatous ulcers.

The aorta of the three remaining animals showed decided evidence of late degenerative changes. These changes existed as well defined punched out or scooped out atheromatous ulcers. Their location, with one exception, was in the arch of the aorta. The inner and middle coats of the vessel were always involved, the floor of the ulcer usually being formed by the outer part of the middle coat. In the aorta of one of the animals the ulceration was very extensive. The ulcers were large, had a scooped out

appearance, and were found in the abdominal as well as the upper aorta. The floor of one of these ulcers was formed by the outer coat of the vessel, which was bulged out on the surface as a sacculated aneurism. A detailed account of this work has been published in The Archives of Internal Medicine. We feel certain that degenerative changes can be produced in the vessels of the rabbit by the use of alcohol. On account of the small number of animals used the report is preliminary in its character.

The question naturally arises, might not these changes which were found in the vessels have developed spontaneously and not be ascribable to the alcohol action.

To eliminate this possible source of error the vessels of eighteen presumably normal rabbits were removed and studied microscopically. In fifteen of the vessels there was no evidence of general or localized sclerosis. In the remaining three vessels there was in one a small round cell infiltration of the media. In the other two there were a few patches of thickening of the internal coat, which were in the early stages of the formation of atheromatous ulcers.

The second point of this work was to determine, if possible, the cause of the vascular degeneration. The following observations, we hope, will have some weight and throw some light on this side of the question. Those animals which did not develop arterial changes, and those in which these changes were only slight, gained in weight under the use of alcohol, had good appetites, and showed no sign during life or at the post-mortem of gastro-intestinal irritation; while those animals which developed the most pronounced vascular changes, and those in which these changes were fairly severe, lost in weight under the use of alcohol, had a poor appetite, and a diarrhoea during most of the time the alcohol was being used. At the post-mortem such animals showed an acute diffuse enteritis of moderate severity.

All of the animals were receiving the same amount and the same strength of alcohol. Some developed gastro-enteritis and in these arterial changes were most pronounced. Others did not develop a gastro-enteritis and in these animals there was either no arterio-sclerosis or the arterial changes were slight. Evidently

some factor other than the alcohol *per se* has an influence in the production of degenerations of the blood vessels. Just what this is we are at present in no position to say. The apparent fact certainly affords an interesting field for speculation and investigation. It is not unlikely that in some individuals as well as in some animals alcohol causes an acute catarrhal state of the stomach and intestines. As a result of this increased amount of blood to the mucous glands of the stomach and intestine they become hyperactive and produce an excessive amount of mucous which is discharged into the intestine and here decomposes with the liberation of organic acids and other bodies which are absorbed and lead primarily to a chronic auto-intoxication, and secondarily to vascular degeneration.

CONCLUSIONS

1. When used externally in weak solutions alcohol is directly and indirectly a germicide.

2. When used in weak solutions, in the stomach and intestine, it acts mildly as an irritant, increases the amount of blood to these structures, and increases the functional activity of the gastric and intestinal glands.

3. In strong solutions, by acting as a gastric irritant it reflexly increases the rate and perhaps the force of the heart beat.

4. After absorption it has no direct effect upon the circulatory system but through its sedative action on the central nervous system it prevents the heart from being over stimulated and in this way is of distinct value in some of the acute infectious diseases.

5. Arterial degeneration may be produced in the lower animals by alcohol.

6. The degenerative vascular changes are likely not entirely due, primarily to the alcohol acting as such, but to the absorption of products from the intestine which the alcohol has indirectly caused to be formed.

CHAPEL HILL, N. C.

DRAINAGE OF NORTH CAROLINA SWAMP LANDS *

BY JOSEPH HYDE PRATT.

For several years the North Carolina Geological and Economic Survey has been making preliminary examinations of the swamp lands of the State in order to determine:

1. The character of swamp; whether the soil is suitable for agricultural purposes, or whether it is too peaty in character.

2. Whether the peat swamps contain a sufficient quantity of peat and of such quality that it would be marketable.

3. Whether the swamps can profitably be drained for agricultural purposes.

There are approximately 4,505 square miles of swamp lands in eastern North Carolina, besides thousands of acres of "overflow" land, a great deal of which is susceptible of reclamation, if properly drained.

The approximate amount of swamp land in twenty-eight of the eastern counties in North Carolina is as follows:

County	Sq. mi.	County	Sq. mi.
Beaufort	177	Columbus	300
Bladen	192	Cumberland	30
Camden	162	Dare	344
Chowan	80	Gates	45
Craven	238	Jones	139
Currituck	40	New Hanover	25
Duplin	125	Pamlico	325
Hyde	387	Pender	370
Martin	86	Perquimans	92
Onslow	134	Robeson	130
Pasquotank	80	Tyrrell	251
Bertie	57	Pitt	40
Brunswick	300	Sampson	118
Carteret	126	Washington	262
		Total	4,505

Or 2,883,200 acres.

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Several areas in Bladen, Carteret, Craven, Duplin, Onslow, Pasquotank, Pender and Wilson Counties have been examined, and in nearly all cases no engineering difficulty stands in the way of draining these lands. In the early history of the state there were three obstacles in the way of the practical drainage of these swamp lands:

1. The cost of clearing the land, inasmuch as the timber had little or no commercial value at that time.

2. The excessive cost and almost impossibility of digging adequate canals and ditches to take care of the water.

3. The lack of adequate laws that would permit the carrying out of a drainage proposition.

Fortunately, all these obstacles are now removed; the value of the timber on nearly any swamp area is worth more than the cost of clearing the areas for agricultural purposes; the great advance made in the manufacture of dredges now makes it possible to dig canals of any size at comparatively low cost; and the General Assembly of 1909 has passed an act which makes it possible to carry out almost any drainage proposition.

It may be of interest to the readers of the Journal of the American Peat Society to know something regarding this act. The title of the act is as follows:

"An act to promote the public health, convenience and welfare by leveeing, ditching and draining the wet, swamp and overflowed lands of the State, and providing for the establishment of levee or drainage districts for the purpose of enlarging or changing any natural water courses and for digging ditches or canals for securing better drainage or providing better outlets for drainage, for building levees or embankments and installing tide gates or pumping plants for the reclamation of overflowed lands, and prescribing a method of so doing; and providing for the assessment and collecting of the cost and expense of the same, and issuing and selling bonds therefor; and for the care and maintenance of such improvements when constructed."

Under the provisions of this act it is now possible for a majority of the resident land owners in any proposed drainage district, or the owners of three-fifths of all the land which would be

included in the proposed district, to petition the clerk of the superior court of the county in which the greater portion of the swamp area is located that he declare such land a Drainage District. The petitioners file a bond with the clerk equal to $50.00 for each mile of canal that it is estimated would have to be constructed to carry out the drainage proposition, such money to be used in paying the cost of the preliminary examination that the clerk of the court has ordered made; provided, such examination shows that the drainage of the land is not a feasible proposition. For making this preliminary examination, the clerk appoints a competent civil and drainage engineer and two resident freeholders of the county, who shall determine:

1. Whether the proposed drainage is practicable or not.
2. Whether it will benefit the public health or any public highway, or be conducive to the general welfare of the community.
3. Whether the improvement proposed will benefit the land sought to be benefited.
4. Whether or not all lands that are benefited are included in the proposed Drainage District.

On the filing of this preliminary report, if favorable, the clerk appoints a certain day when the report shall be further heard and considered, at which time any one interested in the drainage proposed may appear before the court and give reasons why his lands should not be included in the Drainage District, and why he thinks the proposition is not feasible, or why he thinks the cost will be greater than the benefit. If the court does not sustain him in his objections, he has the right to appeal to the superior court of the county in term time; provided he accompanies his appeal with a bond acceptable to the clerk of the court. After the objections to this preliminary survey have all been settled, the clerk shall order that a complete survey and report shall be made of the district, that plans and specifications shall be drawn up showing the locations of the canals and ditches, methods of construction and estimated cost. The viewers shall determine the ratio of benefit that each acre will receive by drainage, and, in making the assessment against each acre this ratio shall be used. In classifying the lands to

determine the ratio of benefits, consideration is given to the degree of wetness of the land, its proximity to the ditch or a natural outlet, and the fertility of the soil.

The land thus benefited shall be separated into five classes: The land receiving the highest benefit shall be marked "Class A;" that receiving the next highest benefit, "Class B;" that receiving the next highest benefit, "Class C;" that receiving the next highest benefit, "Class D;" and that receiving the smallest benefit, "Class E." The holdings of any one land owner need not necessarily be all in one class, but the number of acres in each class shall be ascertained, though their boundary need not be marked on the ground or shown on the map. The total number of acres owned by one person in each class and the total number of acres benefited shall be determined. The total number of acres of each class in the entire district shall be obtained and presented in tabulated form. The scale of assessment upon the several classes of land returned by the engineer and viewers shall be in the ratio of 1, 2, 3, 4 and 5—that is to say, as often as 5 mills per acre is assessed against the land in Class A, 4 mills per acre shall be assessed against the land in Class B, 3 mills per acre in Class C, 2 mills per acre in Class D, and 1 mill per acre in Class E. This shall form the basis of the assessment of benefits to the lands for drainage purposes.

When this final report is handed in to the clerk of the court, he shall notify all the land owners that upon a certain date there will be a hearing of the said report at which any land owner may appear in person, or by counsel, and file his objections in writing to the report of the viewers. It shall be the duty of the court to carefully review the report and the objections filed thereto. If, in the opinion of the court, the cost of construction, together with the amount of damage assessed, is not greater than the benefits that will accrue to the land affected, and if the assessments are just and equitable, the court shall confirm the report of the viewers and declare the Drainage District established. If, however, the court does not confirm the report, the proceedings shall be dismissed at the cost of the petitioners. During the hearing of this court, any land owner has the privilege of appealing from

the decision of the court to the superior court in term time, and the establishment of the Drainage District is delayed until such appeal is settled.

As soon as the Drainage District is declared established, the court shall appoint three disinterested persons, who are known as the "Board of Drainage Commissioners," and they are immediately created a body corporate under the name and style of "The Board of Drainage Commissioners of ——— District." This board of commissioners has the power to issue bonds of sufficient amount to cover the cost of drainage, the land being collateral for the bonds, none of which can be sold below par. The bonds are thirteen-year bonds, payable in ten installments, the first installment to be due at the end of three years from the issuing of the bonds, the same to bear 6% interest. The money necessary to pay the interest and bond issue is raised by assessment on the land, according to the benefits derived, as mentioned above. This assessment constitutes the first and paramount lien, second only to state and county taxes, upon the land assessed, and is to be collected in the same manner and by the same officer as state and county taxes.

Provisions are also made in the act for crossing land with a ditch, for crossing highways and railroads, for notifying the railroads of such crossings, and for assessments of damages upon them and upon individuals. Provision is also made for the control and repair of the canals and ditches after they have been once constructed. In order to protect the ditches, canals, levees, etc., that have been constructed in carrying out the plans for the Drainage Districts, the act makes it a misdemeanor for any person to injure or damage or obstruct in any way these ditches and canals.

As a result of the passage of this act, six drainage districts are already in the course of formation: one in Currituck County, known as the Moyock Drainage District; one in Hyde County, which contemplates the drainage of Lake Mattamuskeet and about 70,000 acres adjoining it, making a total of about 120,000 acres in the drainage district; another in Beaufort County, north of Belhaven, containing approximately 25,000 acres; 4,000 acres

in Pender and Duplin Counties, known as Angola Bay Swamp, containing possibly 47,000 acres; 5,000 acres in Pender and Bladen Counties, which contemplates the reclamation of a large and fertile area in Lion Swamp, and 6,000 acres near Wilson, Wilson County.

Work has already been commenced in the Moyock District, the Wilson, and one in Beaufort County. Plans and specifications have been drawn up for the drainage of Lake Mattamuskeet, Angola Bay and the Lion Swamp areas. An application has also been received for the establishment of a Drainage District in Chowan County.

The above will show the interest that has already begun to be taken in the drainage of North Carolina swamp lands. It has been known for a long time that many thousands of acres of these swamp lands contain the most fertile soil to be found in the state, and now that the General Assembly has made drainage possible, there is plenty of capital ready to undertake the drainage of these fertile swamp lands, realizing that they will be able to dispose of the lands at a good profit after they have been thoroughly drained.

The drainage of the vast swamp areas of eastern North Carolina means not only additional wealth to the state, in the form of reclaimed agricultural lands, but it will mean improved roads through large areas that are now practically impassable and inaccessible. It will also mean better school facilities for the children and it will greatly improve the healthfulness of this section of the state.

CHAPEL HILL, N. C.

THE MINERAL PRODUCTION IN NORTH CAROLINA DURING 1908*

BY JOSEPH HYDE PRATT

The financial stringency and general business depression that swept over this country the latter part of 1907 and the greater portion of 1908 had a decided effect upon the mineral production of North Carolina during 1908. This was felt especially in the building stone and clay product industries, which are largely dependent upon building trades for their market. As these form by far the larger portion of the mineral production of the state, there was, consequently, a considerable falling off in the total value. Its effect, however, was also noticed in the production of practically all of the minerals of the state, there being but one or two that showed any increase in production for 1908 over that of 1907.

The total value of the mineral production for 1908 was $2, 307,-116, as compared with $3,173,722, value of the 1907 production, a decrease of $766,606. This mineral production can be readily divided into four divisions:

1. The production of the metals, gold, silver, copper and iron;
2. The production of non-metallic minerals, as talc, barytes, etc.;
3. Structural materials, as building stone, brick, etc.; and
4. Pottery clays.

There is given in the table below the value of the 1908 production divided up according to these divisions:

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*Reprinted with slight changes from Press Bulletin No. 33, North Carolina Geological and Economic Survey, No. 26, 1909.

Metals	$ 177,600
Non-metallic minerals	258,902
Structural materials	1,771,603
Pottery and pottery clays	99,011
Total value	$2,307,116

In the production of the precious metals, North Carolina easily maintains first place in the Eastern States, although its total production is small. The gold production of 1908 was 4,716.32 fine ounces, valued at $97,945, an increase of 740.24 fine ounces, and of $15,302 in value over the production of 1907. The county producing the largest amount of this production was Montgomery, with Rowan second. The output of silver and copper, which are very closely related to each other, was very greatly below the production of 1907, the copper being valued at only $2,560, as compared with $116,410, the value of the 1907 production. All of the principal copper mines were idle during 1908.

In the non-metallic minerals there was a slight increase in the production of millstones, but a decided decrease in the production of all the others.

The value of the structural materials produced during 1908, of $1,771,603, was a decrease of $389,415, as compared with $2,161,018, the value of the production of 1907. The greatest decrease was in the production of granite and common brick. In 1907 the value of the granite production was $906,476, while in 1908 it dropped to $802,927, a decrease of $103,549. The production of common brick in 1907 was 174,750,000, valued at $1,150,185, while the production of 1908 has fallen off to 144,192,000 brick, valued at $900,611. There were slight gains in the production of sand-stone, marble, and lime.

The value of the production of pottery and pottery clays in 1908 was $99,011, an increase of $3,284, as compared with $95,727, the value of the 1907 production. There is given in the table, on page 167, the mineral production in North Carolina for the years 1903-1908, inclusive. With the exception of gold, the production of all the minerals was affected by the financial condi-

tion of the country, and in many cases the increase or decrease in the production of a mineral is entirely due to increased prosperity or financial depression of the country. With some of the minerals, however, the decrease is due to other causes, such as excessive cost of production or working out of deposits.

Comparing the production of the various minerals during 1908 with those of the five previous years it will be seen that up to 1908 there has been a gradual increase in the production of those minerals which make up the larger proportion of the mineral production of the State, such as clay products, stone, monazite, mica and copper. The total value of the mineral products for 1908 is the lowest recorded since 1904, and up to this year there had been a steady increase in the total value of the products since 1900, when these statistics were first collected, with the exception of the year 1902.

During the past year many new mining properties have been opened up and developed and many inquiries have been received relating to the occurrence of different minerals of the State, which would indicate that the mineral production for 1909 would be considerably in excess of that of the previous year (see table on opposite page).

THE MINERAL PRODUCTION IN NORTH CAROLINA FOR THE YEARS 1903-1908.

Mineral.	Value.					
	1903.	1904.	1905.	1906.	1907.	1908.
Gold	$ 113,604	$ 123,924	$ 129,153	$ 122,008	$ 82,195	$ 97,495
Silver	16,907	19,132	20,216	30,944	14,299	668
Copper	67,037	36,600	88,000	135,829	116,416	2,560
Iron	78,540	79,846	70,352	75,638	113,488	76,877
Garnet and Corundum	12,250	6,586	9,000	.....	13,500	.....
Millstones	902	6,500	2,652	4,110	1,969	4,052
Mica. Sheet	86,300	100,724	100,900	205,756	209,956	114,540
Mica. Scrap	2,400	3,410	3,375	11,940	15,250	13,330
Quartz	36,827	36,269	13,659	12,578	1,664	.....
Precious stones	1,525	10,600	3,350	5,000	7,580	570
Rare minerals	270	160	.....	.....	9,300	.....
Monazite	58,694	79,438	107,324	125,510	54,824	37,224
Zircon	570	200	1,600	248	46	.....
Barytes	21,347	33,930	21,670	10,020	18,855	10,580
Talc and pyrophyllite	76,984	65,483	74,940	66,979	74,347	51,443
Mineral water	13,085	21,902	38,755	31,413	40,302	27,163
Graphite	248	525	475	475	.....	.....
Coal	25,300	8,820	2,336	.....	.....	.....
Stone	360,322	312,576	597,922	854,301	956,919	824,927
Sand and gravel	.....	.....	547	9,191	2,191	2,070
Sand-lime brick	.....	17,500	29,103	32,975	38,808	14,000
Kaolin and other clays	76,000	76,670	85,622	90,036	85,505	85,649
Clay products	866,458	944,880	1,038,430	1,182,660	1,316,308	943,968
Total value	$1,915,570	$1,985,675	$2,439,381	$3,007,601	$3,173,722	$2,307,116

A general discussion of the mining industry in North Carolina during the year 1908 will be given in Economic Paper No. 18 of the Publication of the N. C. Geological and Economic Survey, Chapel Hill, N. C.

CHAPEL HILL, N. C.

ADDITIONS TO THE FLORA OF THE CAROLINAS*

BY W. C. COKER

Collections made at intervals at Chapel Hill, Orange County, North Carolina, and in Darlington County, South Carolina, have resulted in the addition of the following species to the known flora of these states:

ACER FLORIDANUM (Chapman) Pax.

This tree is not uncommon on the sandy banks and alluvial bottoms of Morgan's Creek, near Chapel Hill, North Carolina. I have found it at several places here; and there are a number of medium-sized trees on the streets in the town of Chapel Hill that have been brought in from the surrounding country. In the creek bottoms the tree grows to a large size, forty feet or more high and two or more feet in diameter. The species has not been reported before from North Carolina, and the only South Carolina collection seems to be from "near Charleston" by J. H. Mellichamp, 1896 (herb. N. Y. Bot. Garden). It is possible that this collection was made from a tree brought in from a distance and planted by Michaux, but supposing it to be native at Charleston, the discovery of this species at Chapel Hill extends its known range about 230 miles northward.

Acer floridanum seems to approach nearest to *Acer leucoderme* Small, but according to Dr. Small the two are quite distinct, not only in characters of foliage and fruit, but also in habit. I have not seen *A. leucoderme* in the field, but it is said to be a shrub or small tree, preferring rocky banks in the piedmont or middle dis-

*Reprinted from the Bulletin of the Torrey Botanical Club, **36:** 635-638. 1909.

tricts, while *A. floridanum* is a large tree of alluvial bottoms, and confined principally to the coastal regions. That *A. leucoderme* also is present in Orange County seems certain, as it has been collected in the adjoining county of Durham to the east (herb. N. Y. Bot. Garden, from Biltmore Herb.).

HABENARIA NUTTALLII Small.

Collected in wet soil on the south side of Paper Mill Lake, Hartsville, South Carolina, August, 1908. This orchid has not been collected before in the state of South Carolina, and only at Wilmington in North Carolina (herb. N. Y. Bot. Garden, *W. M. Canby*, 1867). Towards the south it has not been found nearer than Florida and southern Georgia.

SOLIDAGO VERNA M. A. Curtis.

Collected on earth dam opposite Paper Mill, Hartsville, South Carolina, May, 1909. Hitherto this very rare plant has not been found except in eastern North Carolina and no exact locality is known except near Wilmington, where it was discovered by Rev. M. A. Curtis.

In the Flora of North America, Torrey and Gray (2: 205. 1842), *S. verna* is given on authority of Curtis from "open sandy pine woods near Wilmington, and Lenoir County, North Carolina," to which is added "(Florida, *Herb. Rafinesque!*)." But in Gray's Synoptical Flora of North America, Lenoir County, North Carolina, and Florida are omitted from its habitat and it is given only from "open and sandy pine woods near Wilmington, N. Carolina, *Curtis.*" From this it would seem that its occurrence in Florida has not been established; but as to Lenoir County, which lies some seventy miles north of Wilmington, if Curtis said he found it there, its occurrence there can scarcely be doubted. In his "Catalogue of the Indigenous and Naturalized Plants" of North Carolina (Geol. and Nat. History Survey of North Carolina, Part III, Raleigh, 1867) Dr. Curtis himself gives *S. verna* only from the low districts "(low dist.)."

So far as I have been able to discover, *S. verna* has been distributed only by Rev. M. A. Curtis, Dr. T. F. Wood, and Mr.

Gerald McCarthy, all of whom seem to have collected their plants around Wilmington. The species is listed in Wood and McCarthy's Wilmington Flora (Journal of the Elisha Mitchell Scientific Society, 3: 77. 1886), and in McCarthy's distribution list of "Flora of Eastern North Carolina" of 1885.

The occurrence of the plant at Hartsville, South Carolina, extends its range about one hundred and ten miles to the westward.

JUNCUS ABORTIVUS Chapman.

Four plants were collected in a damp grassy meadow in Burnt Bay about one-third of a mile behind the residence of Maj. J. L. Coker, Hartsville, South Carolina. Comparison with a sheet from Chapman's own herbarium leaves no doubt that this determination is correct. The species has heretofore been known only from western Florida near the coast. The Hartsville station extends its range over four hundred miles northward.

SCRIPUS SUBTERMINIALIS Torr.

A large quantity of this rush, hitherto supposed to be entirely northern, was found in the stream just below the "race" at Kilgore's Mill, about one mile from Hartsville. The species ranges across the northern part of the United States and Canada and has not been reported before south of New Jersey. However, on examining the sheets of this species at the New York Botanical Garden, it was found that it had been collected at Morrisonville, Mississippi, by S. M. Tracy in 1898. It is therefore probable that the species will be found to extend over the Southeastern and Gulf states.

CYPERUS MARTINDALEI Britton.

This small sedge is very common in the sand hills near Hartsville, South Carolina. It has not been known before except from Florida and the Gulf Coast.

CROTALARIA PURSHII DC.

Reported in Small's Flora from "Georgia and Florida to Louisiana," and it does not seem to have been reported farther to the northeast. It was collected by me at Hartsville, South Carolina, in flat sandy pine-barrens and it has been collected by House in Oconee County, South Carolina, in 1906, and by Huger in North Carolina (herb. N. Y. Bot. Garden).

VACCINIUM FUSCATUM Ait.

Given in Small's Flora from "Georgia to Florida, Arkansas and Louisiana," and supposed to be a Florida and Gulf Coast plant. The species was collected in wet soil in "Burnt Bay," Hartsville, South Carolina, May 24, 1909. This extends its range three hundred miles northward.

GENTIANA ELLIOTTII Chapman [*Dasytephana parvifolia* (Chapm.) Small].

In the fall of 1907 a pure white form of this species was collected on the side of a ditch near the Pee Dee river at Society Hill, Darlington County, South Carolina, and sent me by Mr. P. H. Rogers.[1] The plant was again collected by Mr. Rogers at the same place in October, 1908. The plants are said to have been rather numerous in 1907, but the ditch was worked over soon after and in 1908 there were only a few to be found. I now have four specimens of this interesting form. Albinos seem not to have been previously recorded for this species.

LIMODORUM TUBEROSUM L. (*Calopogon pulchellus* R. Br.).

Three plants of the white form were found among sphagnum on the edge of a bay on the north side of Paper Mill Lake, Hartsville, South Carolina, May 23, 1909, and Mr. P. H. Rogers has since collected it in the vicinity of Hartsville. This albino has been reported from Moor's Landing, New Jersey, by Dr. Britton (Bull. Torrey Club 17: 125. 1890) and by Paine from Genesee County, New York (Cat. Pl. Oneida County, 86. 1865), but I can find no record of its occurrence in the Carolinas. The normal form is plentiful at Hartsville.

In conclusion I wish to thank Dr. John K. Small and Dr. N. L. Britton for assistance extended me in the preparation of this paper.

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[1] It is interesting to note that Society Hill was for several years the home of the gifted botanist, Rev. M. A. Curtis.

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